Comparison of the Effects of Three Approaches on the Frequency of Stimulus Activations, via a Single Switch, by Students With Profound Intellectual Disabilities

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The effects of three classes of reinforcing stimuli were compared across three students with profound intellectual disabilities. A multielement design with no baseline and final "best treatments" phase was used to measure the frequency of single-switch activations by each student across treatments. The three interventions were Treatment A, adapted toys and devices; Treatment B, cause-and-effect commercial software; and Treatment C, instructor-created video programs. Stimulus activations using a single switch were consistently greater when using individualized computer-based video programs. Implications for identifying stimuli for students who may not respond to traditional methods for teaching means–end contingencies (cause and effect) are discussed.

Students with profound disabilities who are nonverbal and have limited control over their movements have been identified as the most challenging in the field of behavior analysis (Ivancic & Bailey, 1996). Providing quality educational programs to these students presents a tremendous challenge (Smith, Gast, Logan, & Jacobs, 2001). Students with severe and profound intellectual or physical disabilities experience limitations in their ability to interact with their environments (Daniels, Sparling, Reilly, & Humphry, 1995) and to learn action (means)–outcome (end) contingencies (Sullivan & Lewis, 1993), also known as cause and effect. Assistive technology, including switches, alternative and augmentative communication devices, and environmental controls, provides an alternative means for students to access their environments, exert control, express themselves, and learn simple tasks (Cook & Hussey, 2002; Daniels et al., 1995). Activation of a single-switch device requires fine or gross motor movements to deliver force through contact with the switch or detection of motion, sound, or light (Brett, 1995). Switch devices serve as an interface between the student and a battery-operated (e.g., portable CD player, jumping toy rabbit, and radio) or plug-in device (e.g., fan, tape recorder, and water pick) through a wired connection transporting an electronic current to target stimuli (Goossens' & Crain, 1992). Students may further learn that their actions (i.e., pressing a switch) can communicate leisure preferences (Dattillo, 1987), wants and needs, or other information (Dyches, 1999). A single activation of a switch with voice output, operating as a communication device, can enable participation in activities such as the "Pledge of Allegiance," reading a lunch menu, weather discussions, singing repetitive lines in a song, and greeting others (Dyches, 1999).

Studies report the ability of students with severe intellectual disabilities to learn single-switch access (Flanagan, 1982; Lancioni et al., 2002; Meehan, Mineo, & Lyon, 1985; Wacker, Wiggins, Fowler, & Berg, 1988) and to benefit from its use (Johnston, 2003; Lancioni, O'Reilly, & Basili, 2001; Sullivan & Lewis, 1993), including learning cause and effect and control over one's environment (Langley, 1990). Traditionally, teaching cause and effect through switch activation has involved the use of battery-operated toys and devices (Johnston, 2003); however, a limitation with this approach is the provision of variety. Providing a variety of stimuli has been identified as a key component in teaching switch technology (Daniels et al., 1995; Sullivan & Lewis, 1993), yet budgets may restrict the purchase of several reinforcing devices. Teachers may have access to only one or two toys, limiting the rate of skill acquisition due to boredom by the switch user, who finds little difference between a walking, oinking pig and a walking, mooing cow (Johnston, 2003).

In addition to toys and small appliances, a variety of commercially developed computer software programs are available to teach cause and effect via a single switch and switch interface. These programs typically provide motivating features, such as light, sound, music, and animation. Cost may likewise limit the number and variety of programs available in a typical classroom setting, and some teachers may use the same program all year to teach cause and effect to a particular student. Furthermore, the need for repetition in teach-

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ing concepts to this population of students may result in reinforcers losing their effectiveness (satiation) and the students losing interest when the reinforcers are repeatedly presented during teaching sessions or used over a long period of time (Murphy, McSweeney, Smith, & McComas, 2003). A challenge, therefore, is to maintain sustained interest and novelty among task materials and reinforcing stimuli when repetition is required.

The challenge to provide novelty is further compounded when children with severe and profound disabilities exhibit little or no interest in commercially available toys and materials that readily excite children without disabilities, leaving teachers, parents, and therapists with the difficulty of identifying stimuli that hold meaning and interest for these students. Procedures for conducting reinforcer stimulus preference assessments for students with profound disabilities have been reported (Ivancic & Bailey, 1996; Leatherby, Gast, Wolery, & Collins, 1992; Logan et al., 2001; Wacker, Berg, Wiggins, Muldoon, & Cavanaugh, 1985), along with the impact of identification on student response and task performance (Gast et al., 2000; Smith et al., 2001), yet identification of consistent reinforcers can be extremely difficult and complicated (Gast et al., 2000). Whereas Logan et al. reported a direct correlation between lack of progress in learning new skills and the lack of identification of effective reinforcers, Logan and Gast (2001), in their review of the literature on preference assessments, further identified a need to incorporate results of preference assessments into instruction and activities for persons with profound intellectual disabilities. Presented with the possibility that students do not increase their levels of switch use because of their limited interest in contingent stimuli (Lancioni et al., 2001), designers of programs for teaching cause and effect must address the interest of the learner by providing examples and experiences that hold meaning to the student who may have very unique or limited interests. Greater difficulty is presented when meaningful activities or persons that hold meaning for the student are not readily available in the instructional setting (e.g., riding a pony, father chopping wood, garbage trucks, family pets, siblings, and grandparents).

The current study evaluated three approaches for teaching switch-activated cause and effect, including video technology, as a means for providing familiar activities or persons out of context within the classroom setting. This form of video technology uses personally created video recordings that are individually meaningful to the learner (Mechling, 2005). Research has shown this technology to be an effective means for delivering instruction to persons with disabilities to teach a range of skills, such as communication (Charlop-Christy, Le, & Freeman, 2000; D'Ateno, Mangiapanello, & Taylor, 2003); community (Branham, Collins, Schuster, & Kleinert, 1999; Mechling, Pridgen, & Cronin, 2005); social (Embregts, 2003; Taylor, Levin, & Jasper, 1999); daily living (Graves, Collins, Schuster, & Kleiner, 2005); and self-help (Hagiwara & Myles, 1999; Norman, Collins, & Schuster, 2001). Of particular interest to the current study are the results of the Mechling, Gast, and Cronin (2006) research, which demonstrated the effectiveness of using computer-based video technology to present choice of preferred stimuli not readily available in a classroom setting. Presentation of preferred items paired with choice served as reinforcement to increase task completion for two students with disabilities.

The current study was designed to address the need to teach cause and effect to students with profound intellectual disabilities and the difficulty of presenting meaningful items of interest in a classroom setting. The purpose was to compare the effects of three stimulus classes of reinforcement: (a) traditional switch-activated toys and devices; (b) commercially available cause-and-effect software programs; and (c) instructor-created, student-specific, computer-based video recordings, on the frequency of single-switch activations by students with profound intellectual disabilities.

Method

Participants

Three students were selected based on their emerging cause-and-effect skills. Each was able to use a single switch to activate devices, but use was inconsistent. Informal observations of students prior to the study, review of Individualized Education Programs (IEPs), and teacher interviews indicated that each was able to activate a single switch but did not sustain attention without verbal prompting by the classroom teacher. Prerequisite skills for inclusion in the study were (a) motor behavior to activate a single switch, (b) sensory skills (hearing or vision) to recognize stimuli and switch activation, and (c) profound intellectual disability. IEPs for each student reflected a need for consistency and increased frequency of switch activations. None of the students had independent expressive communication systems, nor did they respond consistently to verbal, gestural, or physical prompts. All required assistance with self-care, including toileting.

Adam was a 6-year, 6-month-old boy diagnosed with cerebral palsy and significant development delay (age equivalent: 11 months, *Bayley Scales of Infant Development II* [Bayley, 1993]). He was fed through a gastrostomy tube, was recently equipped with a power wheelchair, and was learning to hold his head upright in the midline position. He activated a switch using the top of his head by straightening and extending his body upright into a pillow switch (Enabling Devices, *www.enablingdevices.com*) mounted to his wheelchair. He smiled, cried, laughed, and vocalized with open vowel sounds to communicate displeasure, pain, and happiness. He enjoyed music, interaction with peers, movement toys, sensory toys, swimming, and interacting with peers and adults.

Cameron was a 5-year, 6-month-old boy diagnosed with cerebral palsy, with hypertonicity in his upper and lower extremities, and functioning at a 6- to 12-month level (*Hawaii Early Learning Profile* [H.E.L.P.; Vort Corporation, 1997–

2006]). His visual acuity was uncertain, and he wore glasses as a result of retinopathy of prematurity. He was fed through a gastrostomy tube. His use of his hands was limited, but he was able to reach out and use a palmer grasp to hold some objects, although with difficulty releasing. He activated a vertically mounted 5-in.-round Big Red® switch (AbleNet, *www.ablenetinc.com*) by extending his left arm and hand. He was able to make some vocalizations, smile, and use head and arm movements to communicate pleasure, and he displayed these behaviors in response to quiet, soft plush toys with movement, but exhibited a startle (extended) reaction to loud noise or music. He also responded positively to vibration and sensory toys. He was described as very happy, was visually and auditorily alert to people in his environment, and enjoyed interacting with family members.

Kyle was an 18-year, 10-month-old young man diagnosed with cerebral palsy and was functioning at a 13-month level (IQ 24, *Bayley Scales of Infant Development II*). He was able to extend his right arm, open his right hand, and activate a small 2.5-in.-round Jelly Bean® switch (AbleNet) placed on the table at midline. He smiled and was able to make some vocalizations and facial expressions to indicate wants and needs. He rejected activities by pushing away items or persons. He responded positively to swimming, listening to music, bowling, interacting with high school peers, and watching his instructors engaged in activities. He was able to walk short distances with a posterior walker.

Setting and Positioning

All sessions were conducted one-on-one in isolated areas to decrease distractions. Adam was taken to an isolated hallway, Kyle was taken to a conference room, and Cameron remained in his classroom while his classmates went to lunch. Adam and Cameron were seated in their respective wheelchairs during intervention sessions, whereas Kyle sat in a classroom chair without adaptations. Adam was supported with a lap tray, elbows and forearms resting on the tray. Classroom chairs or wheelchairs were placed in front of a table with the toy, appliance, or laptop computer positioned directly in front of the student at midline. The exception was the vibration toy, which was placed around the student's neck. Adam required the items to be placed on top of a box 1 ft above his lap tray to support head control in an upright position. His switch was positioned above his head, whereas Kyle's was placed flat on the table at midline, and Cameron's was placed vertically, 1 ft to the left of midline.

Material and Equipment

Single Switches and Equipment. A Dell Latitude 300 laptop computer was used to present cause-and-effect software and individualized computer-based video programs. A single switch was used by each student to activate toys, devices, and computer programs. Cameron used a 5-in. Big Red switch (AbleNet) mounted vertically on a Maxess switch mount (Maxess Products, Ltd, *www.maxessproducts.co.uk*), whereas Kyle's 2.5-in. Jelly Bean switch (ableNet, n.d.) was placed flat on the table. Adam used a 3-in. pillow switch (Enabling Devices) with a head mounting system attached to his wheelchair.

A Choice Switch Latch and Timer (AbleNet) was used to interface the switch with adapted battery-operated toys and devices. This device allowed control of the amount of time (10 s) the stimulus operated once the switch was activated. The "latch" function on the interface allowed one activation of the switch to operate the device for 10 s, thus alleviating the need for sustained pressure or contact with the switch by students. The PowerLink 3 control unit (AbleNet) was used to interface Kyle's switch with the electric radio. This device was also equipped with a latch function, which allowed one-switch activation to operate the radio for 10 s.

Switch Interface Pro 5.0 (Don Johnston, n.d.) was the peripheral used to interface the single switch with the computer to run the commercial cause-and-effect software programs and individualized video programs.

Adapted Toys and Devices. Three novel (new to the student) toys or devices were selected for each student (see Table 1). Rikky the Rooster, Train, and Ring Around Bells (Enabling Devices) were selected as three of the switch-activated toys. The rooster walked and crowed; the bump-and-go train propelled, blew a whistle, and flashed lights; and the bells turned and rang. Tubular Vibrator (Enabling Devices) was a vibrating muscle massager that was placed on the student's lap or shoulders, whereas the Fantastic Clip Fan (AbleNet) emitted small movements of air on the student's body. Battery-operated, indoor wind chimes presented chimes activated by a fan (Nasco, *www.enasco.com*), and the electric radio was set to a rock-and-roll station. The wind chimes required the instructor to hold down a "continuous" button in order for them to play for 10 s after Kyle activated the switch.

Cause-and-Effect Commercial Software. Adam and Cameron used the following three programs: *Teach Me to Talk: Animals* (Softtouch, 1998); *SwitchIt! Weather* (Inclusive TLC, 2002); and *SwitchIt! People* (Inclusive TLC, 2002). Kyle used *SwitchIt! People, Disco* (Inclusive TLC, 1996–1999), and *Teenage Switch Progressions* (R. J. Cooper & Associates, 1988–2000). In addition to providing sound, music, and animation, the three programs selected for Kyle included age-appropriate (young adult) images. *Teach Me to Talk: Animals* was preprogrammed by the manufacturer to operate an animation for 10 s immediately following switch activation, whereas the other four programs were customizable and set for 10-s running time by the investigator. The programs by Inclusive tlc required one screen progression by the instructor to progress the program to the animation level, which was then switch-activated by the student and played the animation for 10 s (e.g., ambulance moving with siren; person playing the drums or making a snowman).

TABLE 1. Switch-Activated Stimuli Across Three Treatments (Sensory Input in Parentheses)

Treatment	Adam	Cameron	Kyle
Treatment A: toys and devices	A1 Ring Around Bells (auditory, visual)	A1 Tubular Vibrator (proprioception)	A1 Tubular Vibrator (proprioception)
	A2 Rikky Rooster (auditory, visual)	A2 Rikky Rooster (auditory, visual)	A2 Battery-Operated Wind Chimes (auditory)
	A3 Train (auditory, visual)	A3 Fantastic Clip Fan (tactile)	A3 Electric Radio (auditory)
Treatment B: cause-and-effect commercial software	B1 *Teach Me to Talk: Animals* (auditory, visual)	B1 *Teach Me to Talk: Animals* (auditory, visual)	B1 *SwitchIt! People* (auditory, visual)
	B2 *SwitchIt! People* (auditory, visual)	B2 *SwitchIt! People* (auditory, visual)	B2 *Teenage Switch Progressions* (auditory, visual)
	B3 *SwitchIt! Weather* (auditory, visual)	B3 *SwitchIt! Weather* (auditory, visual)	B3 Disco (auditory, visual)
Treatment C: instructor-created video programs	C1 Swimming (auditory, visual)	C1 Brother (auditory, visual)	C1 Swimming (auditory, visual)
	C2 Group singing (auditory, visual)	C2 Mother (auditory, visual)	C2 Bowling (auditory, visual)
	C3 Swinging (auditory, visual)	C3 Walking in "Walk About" (mobility equipment, auditory, visual)	C3 Interacting with "peer buddies" (auditory, visual)

Instructor-Created Video Program. The individualized video programs were created using the software program PowerPoint (Microsoft). Video recordings (with sound) of preferred activities and persons (e.g., student swimming, playing with grandmother, and swinging) were made using a Sony digital video camera. Three different events or activities were recorded for each student and then edited using Windows Movie Maker (Microsoft) and saved as 10-s video segments on a CD-ROM. The PowerPoint program was set up under "slide transition" not to advance the slide "on a mouse click" or automatically. Instead, an "action button" was inserted at the bottom right of each slide with an action setting to hyperlink to the next slide. When the video was playing, the instructor moved the cursor off of the video image to prevent stopping of the video if the switch was activated. When the 10-s video stopped, the instructor moved the cursor to cover the action button. The PowerPoint program was programmed to advance to the next slide when the button was activated (i.e., when the student touched the switch), which automatically played the 10-s video segment. The video then stopped and the program remained on that slide until the student activated the switch and advanced the program to the next slide with a new 10-s video segment of the same activity or person.

Data Collection

The number of independent stimulus activations by student switch contacts that activated the toy, device, or commercial or individualized computer software program was measured during a 3-min period and recorded on a data collection sheet (9 min per session). A digital timer was used to monitor the start and stop of each 3-min period. Activations while the toy, device, or computer software program was already running were not counted. Programming features of PowerPoint, PowerLink 3, Choice Switch Latch and Timer, and the commercial software programs permitted setting activation time for 10 s and prevented any effects of switch activations during that time. Contacts made at the end of a stimulus activation that did not result in further activation were not counted. If a student's hand remained on the switch following activation, it was immediately removed by the instructor. The maximum number of stimulus activations per 3-min session was 18.

General Procedures

Stimulus Preference Screening. Prior to the start of the study, teachers and parents were interviewed and students were observed in their classrooms across activities, materials, and people to determine students' sensory preferences. Preferences for sound, animation, music, and touch featured in (a) toys, (b) electronic devices, and (c) commercially available cause-and-effect software were determined by behaviors of orientation, approaches to stimuli, smiling, laughing, vocalizing, and motor movements (Logan et al., 2001). Interviews and observations also determined persons and activities that the student preferred outside of the classroom. Results for features of toys and devices included motion, sound, and music for all three students, whereas Cameron and Kyle also preferred vibration (see Table 1). The cause-and-effect commercial software programs contained the features of music, sound, and animation, whereas instructor-created computer-based video recordings included parents, grandparents, teachers, siblings, and activities such as swimming and swinging.

Intervention Sessions. One 9-min intervention session was implemented per day (2 or 3 days per week). The three 3-min interventions were presented in block rotation with one presentation of each intervention per session: A1, B1, C1; B2, C2, A2; C3, A3, B3; A1, C2, B2; B1, A2, C3; C2, B1, A3; A1, B3, C3; B3, C1, A2; C1, A3, B2 (Alberto & Troutman, 1999). Nine sessions were implemented in order for each of the three toys or devices, commercial software programs, and individualized video programs to be presented three times during the comparison phase of the study. Session length was determined by reported attention span for the students, research on interest levels in contingency activities (Sullivan & Lewis, 1993), and allocation for response latency. Three different toys or small appliances, three commercial software programs, and three individualized computer-based video programs were included to decrease the effects of habituation (Murphy et al., 2003).

In order for students to discriminate between the treatment conditions, immediately prior to the start of each treatment, one 10-s viewing of the stimulus was presented to the student, followed by the presentation of the single switch and start of the 3-min session. No other prompting or reinforcement was provided by the instructor. Each stimulus activation resulted in immediate 10-s viewing of the stimulus. The frequency of independent stimulus activation by a student was measured during the 3-min period.

Experimental Design

The study used a multielement design with no baseline (Kennedy, 2005) and a final "best treatment" phase (J. O. Cooper, Heron, & Heward, 1987) to compare the effects of three contingent consequent events (Treatment A, adapted toys and devices; Treatment B, cause-and-effect commercial software; and Treatment C, instructor created video programs) on the frequency of stimulus activations. The dependent variable was the number of stimulus activations during each 3-min intervention. Daily order of presentation of interventions (treatments) was counterbalanced within sessions to reduce the effects of possible confounding variables, carryover, and order effects. Instructor, time of day, and setting remained constant across the study for each student. Students received intervention in alternating treatments followed by the *best treatment* phase, in which only the most effective intervention was delivered. The *best treatment* phase was delivered to assess possible multiple treatment interference (threat to internal validity) whereby a drop in performance during this phase might signal interference.

Reliability Measures

Interobserver agreement and procedural reliability data were collected simultaneously across 100% of treatment sessions using video recordings. Videotapes were independently evaluated by the independent reliability observer. Interobserver agreement was reported for each stimulus activation by dividing the smaller number of recorded stimulus activations by the larger number of recorded stimulus activations and multiplying by 100. Procedural reliability data were collected on the following instructor behaviors: (a) presenting the 10-s viewing of stimulus prior to treatment condition; (b) adhering to 3-min treatment length; (c) removing the student's hand from the switch when needed; (d) correctly positioning all equipment; and (e) not providing prompts. Procedural reliability agreement was determined by dividing the number of observed instructor behaviors by the number of opportunities to emit behaviors and multiplying by 100 (Billingsley, White, & Munson, 1980).

Mean interobserver agreement for the frequency of stimulus activations was 98.4% across all participants and treatments (range = 90%–100%). Interobserver agreement for individual treatments across all participants was as follows: Treatment A, 98.3%; Treatment B, 97.8%; and Treatment C, 98.8%. Disagreement occurred when a student touched the switch, but it did not activate the device or computer program. Mean procedural agreement was 99.8% across all participants and treatments. Procedural disagreement was due to (a) one failure of the instructor to start the digital timer and use of a watch to estimate completion of 3 min; (b) school announcements that were late and interrupted one session; and (c) batteries that failed with the muscle massager.

Results

Frequency of Stimulus Activations

Figure 1 shows the frequency of independent stimulus activations by each student across the three interventions. All three students demonstrated a greater number of stimulus activations for instructor-created computer-based video recordings when compared with the other two treatments. Mean stimulus activations for the three students across the treatments were Treatment A, 2.2; Treatment B, 3.3; and Treatment C, 6.4 (see Table 2).

Visual inspection of the data paths in Figure 1 reveal patterns of greater performance under Treatment C. Cameron's performance was most pronounced, with an immediate difference in frequency of stimulus activations for Treatment C. Kyle demonstrated the highest number of stimulus activations across three treatments and consistently demonstrated a greater number of stimulus activations with the instructor-created video program; however, examination of the range of stimulus activations (see Table 2) between Treatment B and Treatment C indicate an overlap of distribution of responses

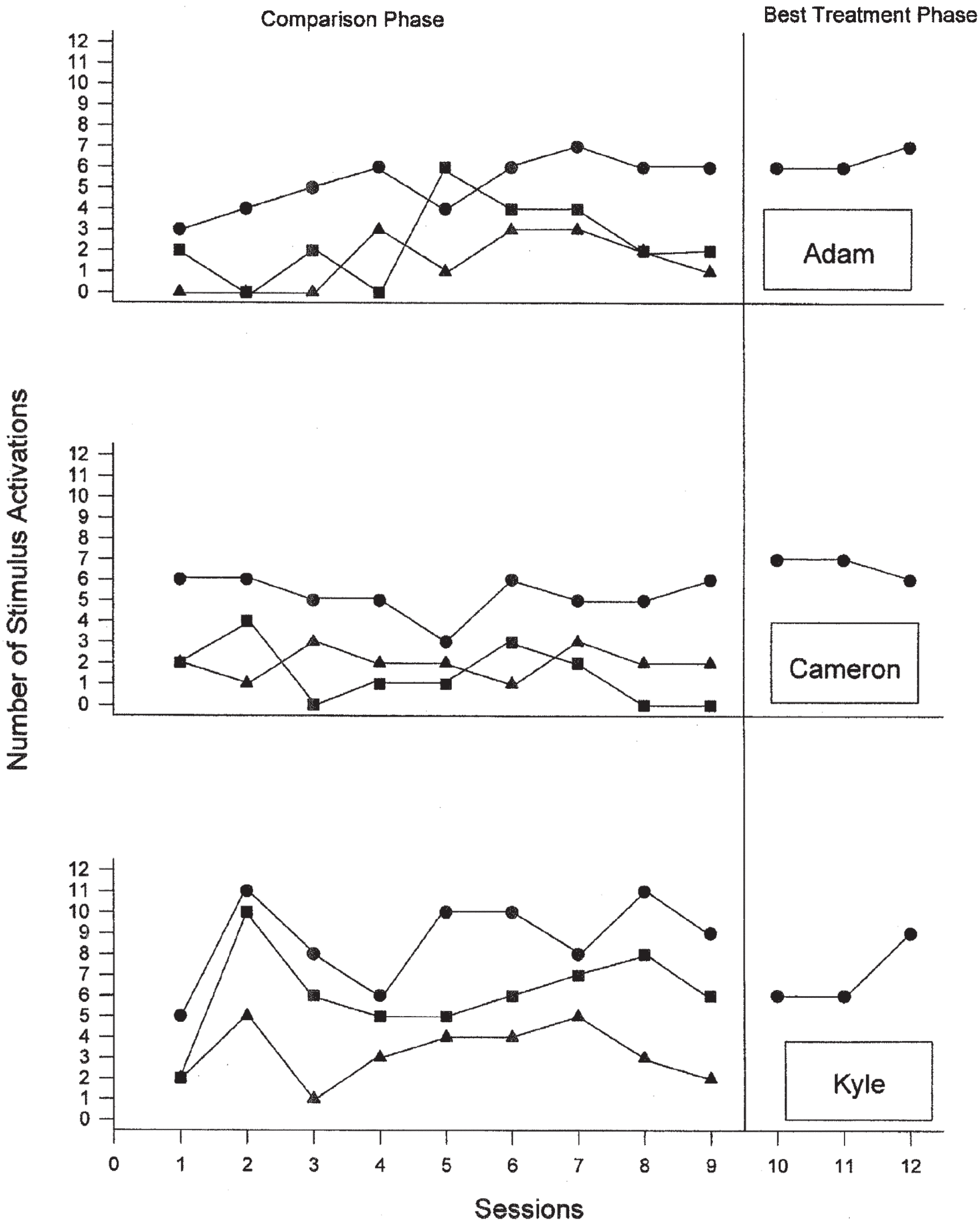

FIGURE 1. Number of stimulus activations for each student across three interventions: Treatment A (triangles), adapted toys and devices; Treatment B (squares), cause-and-effect commercial software; Treatment C (circles), instructor-created video programs.

between the two treatments. Adam was the only student who demonstrated overlap (Kennedy, 2005). He had 11% overlap between Treatment C and Treatment B. No overlap occurred for the other two students between these two treatments. No overlap occurred for the three students between Treatment C and Treatment B.

In the *best treatments* phase, only the most effective treatment (Treatment C) was administered. Adam and Cameron maintained their performance (frequency of stimulus activations) in the *best treatment alone* condition, with Cameron demonstrating an increase in performance (7 stimulus activations across two of three sessions). Kyle maintained

TABLE 2. Summary of the Number of Stimulus Activations for Each Treatment and Student

Treatment	Mean comparison	Best treatment	Median comparison	Best treatment	Mode comparison	Best treatment
Treatment A: toys and devices						
Adam	1.4		1.0		0–3	
Cameron	2.0		2.0		1–3	
Kyle	3.2		3.0		1–5	
Treatment B: cause-and-effect commercial software						
Adam	2.4		2.0		0–6	
Cameron	1.4		1.0		0–4	
Kyle	6.1		6.0		2–10	
Treatment C: instructor-created video programs						
Adam	5.2	6.3	6.0	6.0	3–7	6–7
Cameron	5.2	6.6	5.0	7.0	3–6	6–7
Kyle	8.7	7.0	9.0	6.0	5–11	6–9

his average stimulus activations (8.7) for only one of the three sessions in the *best treatment* phase and performed lower than his average for two of three sessions, which indicates the possibility of multiple treatment interference.

Discussion

Data indicate that the application of personally created video recordings, which are individually meaningful to the learner, was an effective strategy for teaching single-switch activation to students with profound disabilities. In comparison to traditional methods for teaching single-switch use (adapted toys and devices and commercially produced cause-and-effect software), the use of individualized computer-based video programs created by the instructor generated a larger number of stimulus activations for each student.

Despite the positive effects of instructor-created, individualized video programs over the other two interventions, qualification is needed. Each treatment consisted of only three items, and selection of items was based on observation and teacher–parent interviews rather than on formal reinforcement preference testing (Ivancic & Bailey, 1996; Leatherby et al., 1992; Logan et al., 2001; Wacker et al.,1985). Although the commercial software programs were novel and featured graphics, animation, sound, and music, and the novel toys and appliances featured motion, sound, music, and vibration, it is possible that additional selections may have differing effects on the frequency of students' switch activations. It should also be recognized that Kyle did not maintain his performance mean of stimulus activations during the *best treatment* phase. His average dropped from 8.7 to 7.0. One possible reason for this lack of maintenance is the use of the same switch during each treatment condition. Although students viewed 10 s of the different stimuli at the beginning of each treatment to aid discrimination between the treatment conditions, it is possible that provision of a different switch (e.g., color) may have produced different results.

One limitation of the current study was the lack of measurement of effect over an extended period of time. It is possible that different results may have occurred (including habituation) if the instructor-created computer-based video programs were used over time. Prevention of such habituation could be addressed by providing additional video subjects and varied activities. Future research should also evaluate this procedure for teaching cause and effect to students who, unlike those in the current study, have no emerging understanding of means–end relationships.

Assistive technology has done much to improve the quality of life for persons with disabilities, promoting their increased independence (Lane & Mistrett, 1996) and helping them overcome learned helplessness. Through learning that activating a switch can control their environment, students may replace the tendency to acquire learned helplessness or dependency on others with a sense of empowerment and promotion of increased independence (Brett, 1995; York, Nietupski, & Hamre-Nietupski, 1985), including regulation of stimuli, gaining attention, requesting activities, and increasing opportunities to participate in play (Brett).

Technology itself, however, may not provide a means to teach cause and effect without proper attention to the individual and unique interests of students. Results of the current study indicate that individualized computer-based video programs served as a more effective class of reinforcers for switch activation than electronic or battery-operated toys and devices and commercial cause-and-effect software.

Although there has been little recent research on teaching cause and effect through single-switch activation, the use of switch activation to provide the means to gain control over one's environment, participate in meaningful activities, and increase the quality of one's life is undebatable. Switch activation alone may be a means of communication for some learners, whereas early switch use may lead to skills needed to operate more advanced, higher technology devices such as environmental controls and alternative and augmentative communication devices (Lane & Mistrett, 1996).

In the current study, the number of stimulus activations, through use of a single switch, was relatively low for each student; however, results may be considered significant for a population of students who (a) demonstrate inconsistent, limited, or relatively low response to external stimuli (Wacker et al., 1985); (b) make limited progress in learning new skills (Reid, Phillips, & Green, 1991); (c) lack opportunities to explore environments (Daniels et al., 1995; Dattilo, 1987); and (d) are described as some of the most challenging for educational teams (Green, Reid, Rollyson, & Passante, 2005; Smith et al., 2001). For these students, identification of an effective reinforcer is critical as an early step toward the use of operant procedures to teach new skills (Ivancic & Bailey, 1996), yet it remains one of the most difficult tasks for teachers (Logan & Gast, 2001).

The challenge of providing meaningful and high-interest stimuli to students with profound intellectual disabilities remains. As noted by Sullivan and Lewis (1993), the lack of identification of appropriate stimuli may lead to students with more significant physical or intellectual disabilities not responding to traditional cause-and-effect instruction, and therefore not being targeted for sustained instruction. It is therefore imperative that research efforts continue to address this concern. Delivery of stimuli through individually created video programs holds considerable promise. The skills required to develop these programs include the use of PowerPoint, a digital video camera, video streaming directly to the computer, and Windows Movie Maker. The commercial availability of these products and their ease of use by the general public as well as teachers supports current and future applications of this technology. Although commercial products designed specifically to teach cause and effect exist and are frequently used to teach means–end concepts to students with disabilities, results of the current study may encourage interventionists to "think outside the box" of commercially available products when teaching this skill.

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